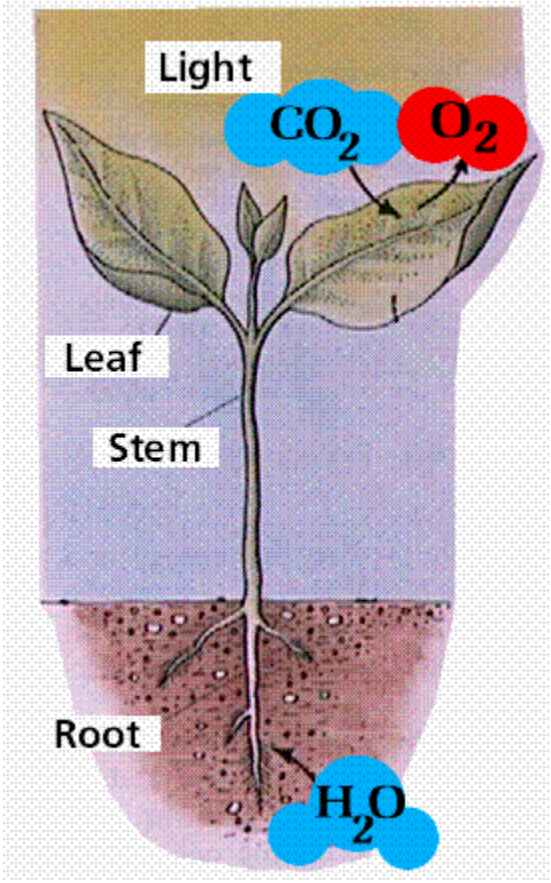
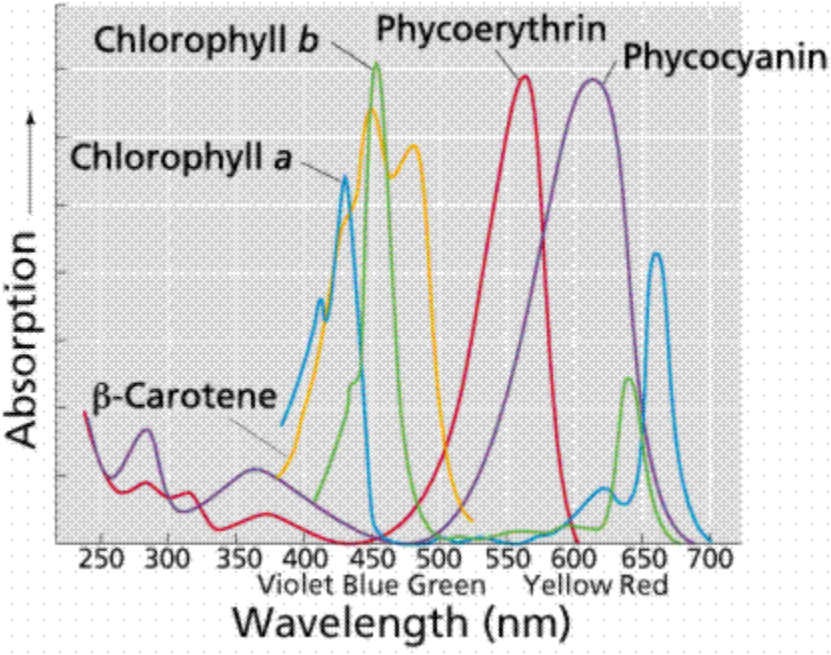
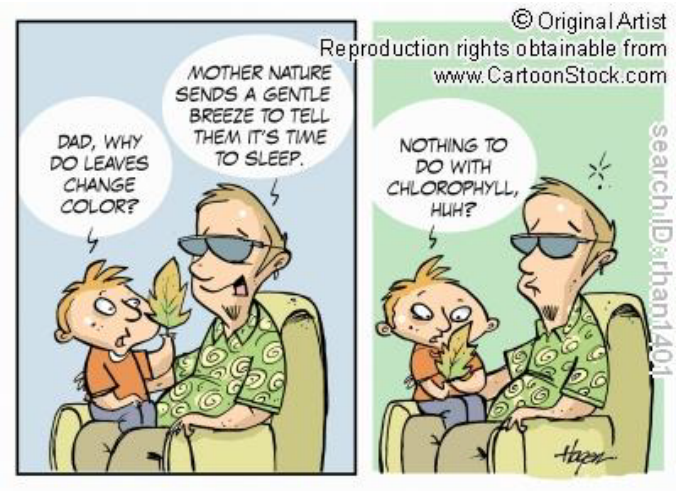
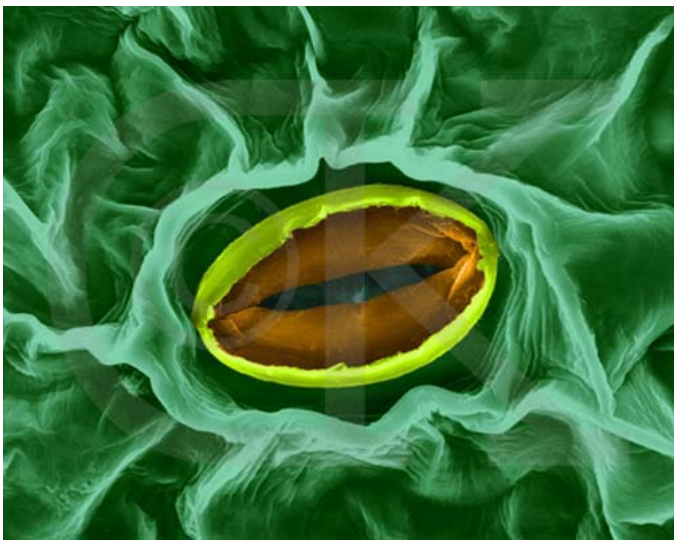
Unit 5a: Photosynthesis and Plant Structure

Term 3 2011-12









Unit 5a: Photosynthesis, Plant Structure and Function

Chapter 5-1, 5-2 and 25

Must Knows	***Key Vocabulary***

1) Students will be able to explain how energy is transferred from the sun during the process of photosynthesis. (Section 5.1 & 5.2 : p. 94-96)
a) Summarize how energy is captured from sunlight in the first stage of photosynthesis.
b) Analyze the function of electron transport chains in the second stage of photosynthesis.
c) Understand the relationship of carbon fixation to the Calvin Cycle in the third stage of photosynthesis.
d) Identify three environmental factors that affect the rate of photosynthesis.
 	
2) Students will be able to understand the tissues and parts of a vascular plant. (Section 25.1 : p. 552-559)
a) The vascular tissue system is made up of two tissues xylem (which conducts water) and phloem (which conducts nutrients).
b) Leaves are the primary photosynthetic organs of plants.
 	
2) Students will be able to understand how water and nutrients are transported in plants. (Section 25.2 : p. 560-564)
a) Water is pulled up from the roots and through the vascular system in the stem and leaves by a process called transpiration.
b) The stoma and guard cells control the amount of transpiration in a plant.
c) Nutrients move from a source in the leaves and delivered to a sink by a process called translocation.
	• Pigment
	• Chlorophyll
	• Carotenoid
	• Thylakoid
	• Electron Transport Chain
	• NADPH
	• Carbon fixation cycle
	• Calvin Cycle
	• Vascular Bundle
	  o Xylem
	  o Phloem
	• Transpiration
	• Translocation
	• Guard cells
	• Stomata
	• Chloroplast
	• ATP

Test Prep CheckList

Have I completed…

Key Terms…

- ☐ **Completed** and **know** all the Word Parts for this unit and the unit before?
- ☐ **Defined** and **studied** (flash cards help) the Key Terms for the Unit?

Reading Circles…

- ☐ **Completed** each of the reading circles for each of the sections in the book?
- ☐ **Taken** and **corrected** each of the Reading Quizzes for each section in the book?

Must Knows…

- ☐ **Identified** and have **written** the appropriate Must Know on the top of each page in the packet
- ☐ **Studied**, **Know** and **asked questions** for each of the Must Knows for this Unit.

Notes…

- ☐ **Taken** Cornell Notes for each day of the unit.
- ☐ **Generated** at least 5 questions for each page of notes.
- ☐ **Summary** is written for each page of notes

Organization…

- ☐ Everyday's Must Knows and Homework is written on the calendar or in an assignment notebook.
- ☐ Cornell Notes are stored in binder.

Word Parts Unit 5a: Photosynthesis

Prefix		Suffix	
auto-		-synthesis	
hetero-		-troph	
photo-		-phob	
Hydro-		-phil	
cyto-			

Using your prefixes and suffixes break the word into parts and define the following:

Word	Prefixes and Suffixes Used	Meaning
cytophobic		
hydrophilic		
heterotroph		
photophobic		

Create the word based on the meaning:

Word	Prefixes and Suffixes Used	Meaning
		To make from light
		Scared of water
		Pertaining to feeding self

Use the word parts above to make 3 other words:

Word	Prefixes and Suffixes Used	Meaning

Define the following word:

Word	Prefixes and Suffixes Used	Meaning
microautophobic		

Unit 5a: Photosynthesis, Plant Structure and Function

Key Terms

Define the following…

- Pigment
- Chlorophyll
- Carotenoid
- Thylakoid
- Electron Transport Chain
- NADPH
- Carbon fixation cycle
- Calvin Cycle
- Vascular Bundle
- Xylem
- Phloem
- Transpiration
- Translocation
- Guard cells
- Stomata
- Chloroplast
- ATP

Must Knows:

_____

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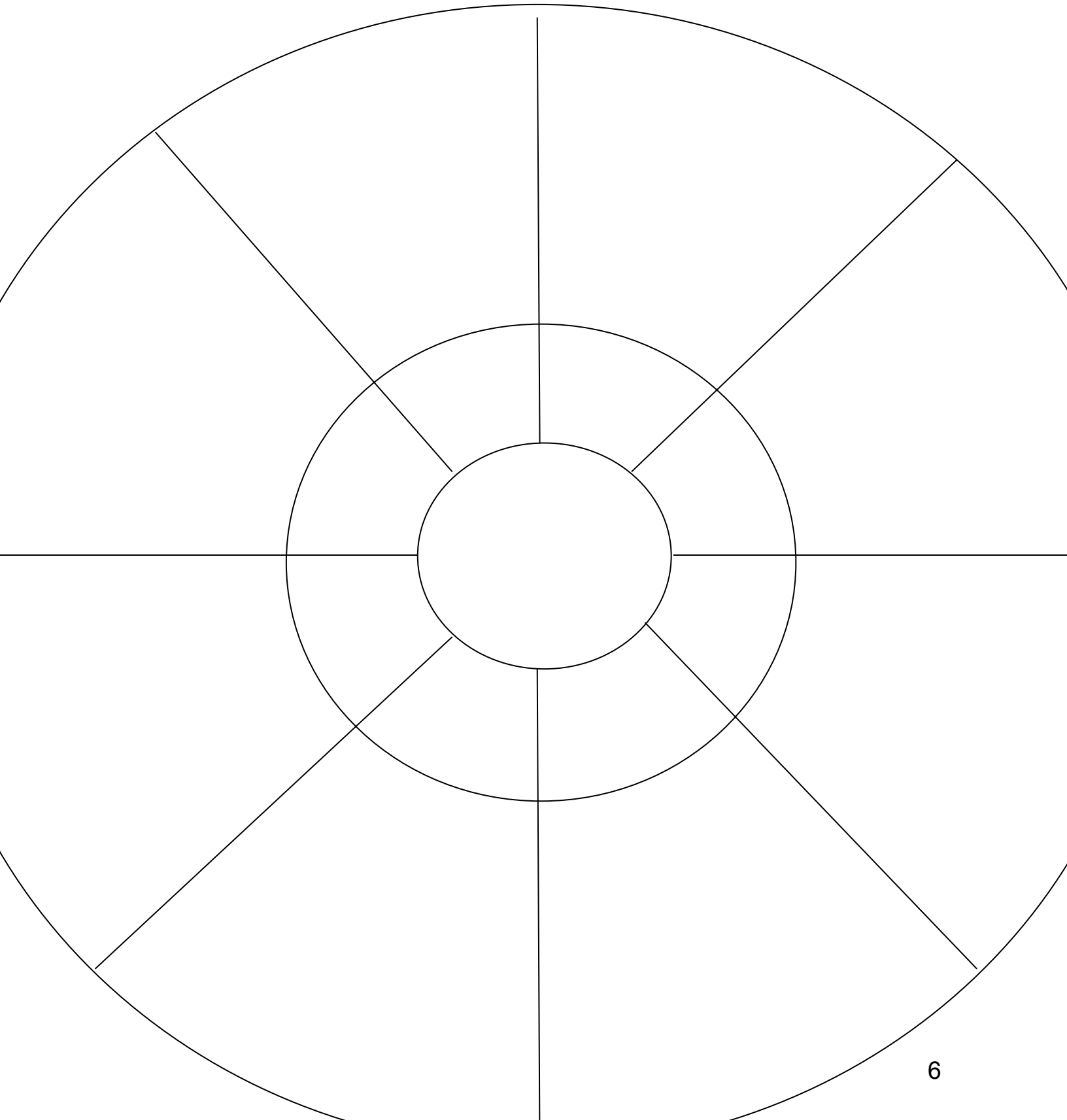

Must Knows:

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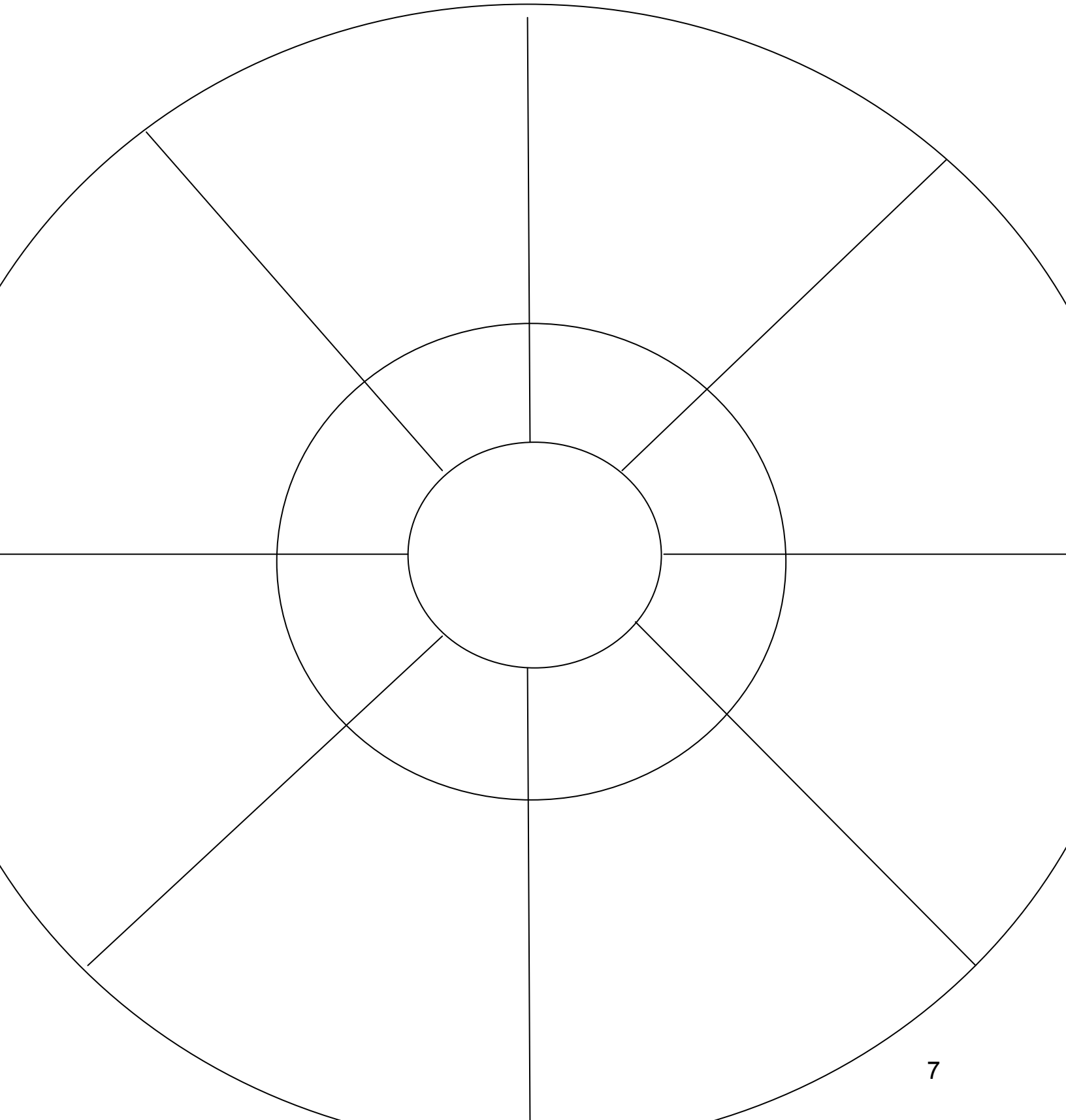

Must Knows:

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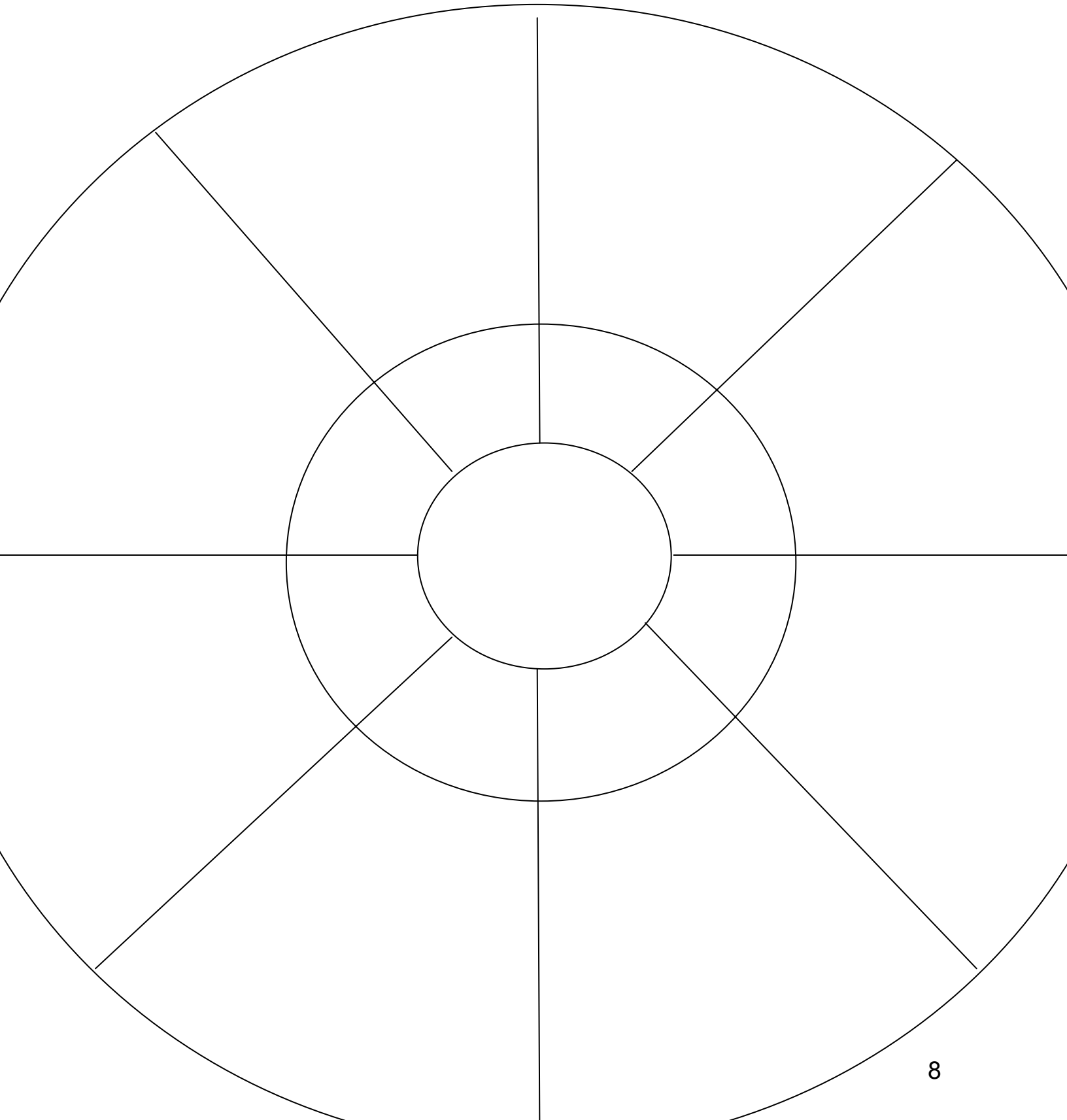

Must Knows:

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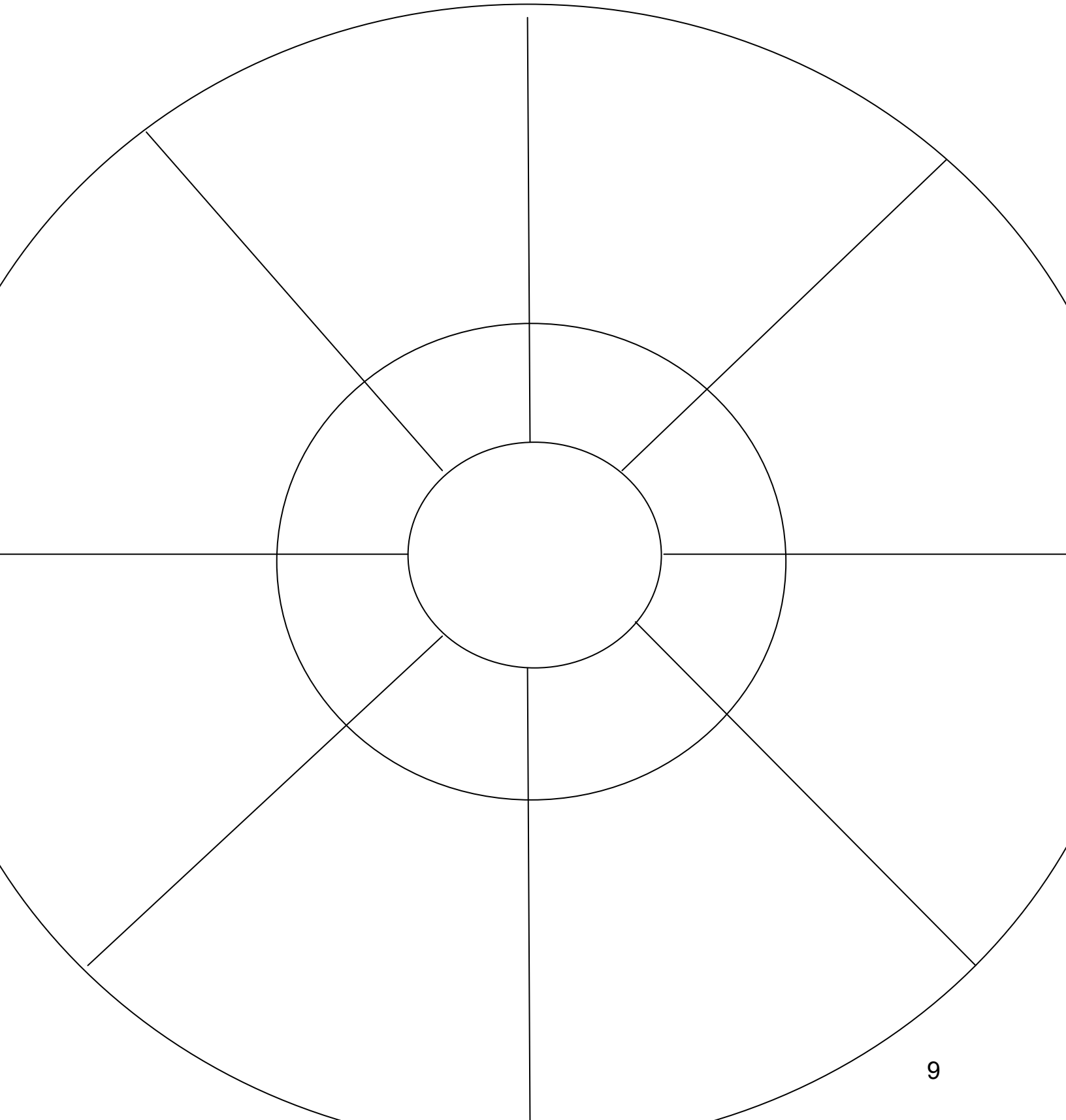


Bell Ringer Worksheet

Question:	**Date:**
Answer:	

Question:	**Date:**
Answer:	

Question:	**Date:**
Answer:	

Question:	Date:
Answer:	

Question:	Date:
Answer:	

Question:	Date:
Answer:	

Chapter 2-8: Energy Flow in Living Things

The total amount of energy that exists in the universe remains constant, but energy can change from one form to another. For example, the chemical energy in gasoline can be released and transformed into heat energy and the energy of motion.

This type of transformation of energy occurs in many of the processes that take place in living things. In this plate, we will examine the flow of energy through living things and identify the molecule that serves as the main energy source in all life processes.

This plate shows how energy exists in different forms at different times in living things. As you encounter the terms, color the appropriate structures in the diagram.

All of the energy on the Earth comes from the **sun (A)**; the **sun's energy (A_1)** is what drives chemical reactions and the processes of life. This solar energy is trapped in a photosynthesizing organelle of the plant called the **chloroplast (B)**; we discuss this organelle in detail later in the book.

A number of chemical reactions take place in the chloroplast to transform solar energy into chemical energy. **Carbon dioxide (C)** and **water (D)** are necessary for the process of **photosynthesis (E)**, and the products of photosynthesis include **carbohydrates (F)**, which are represented by a candy bar, and molecular **oxygen (G)**. The bonds of the carbohydrates now contain some of the sun's energy; photosynthesis has transformed the sun's energy into the chemical energy of the carbohydrate. Oxygen is given off as a waste product of photosynthesis, and it is expelled from the plant cell into the atmosphere.

Having explained how the sun's energy is converted to the chemical energy found in carbohydrates, we will now discuss another transformation of energy. Continue your reading below, and focus on the right side of the diagram as we continue to study energy flow in living things.

Plants, humans, and many other living things use carbohydrates as their essential source of energy. Carbohydrates are transported to an organelle called the **mitochondrion (H)**, where they are combined with oxygen molecules in the process of **respiration (I)**, illustrated by the arrow. During chemical reactions in the mitochondrion, the energy from carbohydrates is released and used to form the energy-rich molecule **adenosine triphosphate (J)**. (Adenosine triphosphate is commonly abbreviated as ATP.) Carbon dioxide and water are byproducts of respiration; notice that they are both essential for photosynthesis. To summarize, the energy of the sun is first transformed into the energy of carbohydrates and then into the energy in the ATP molecule.

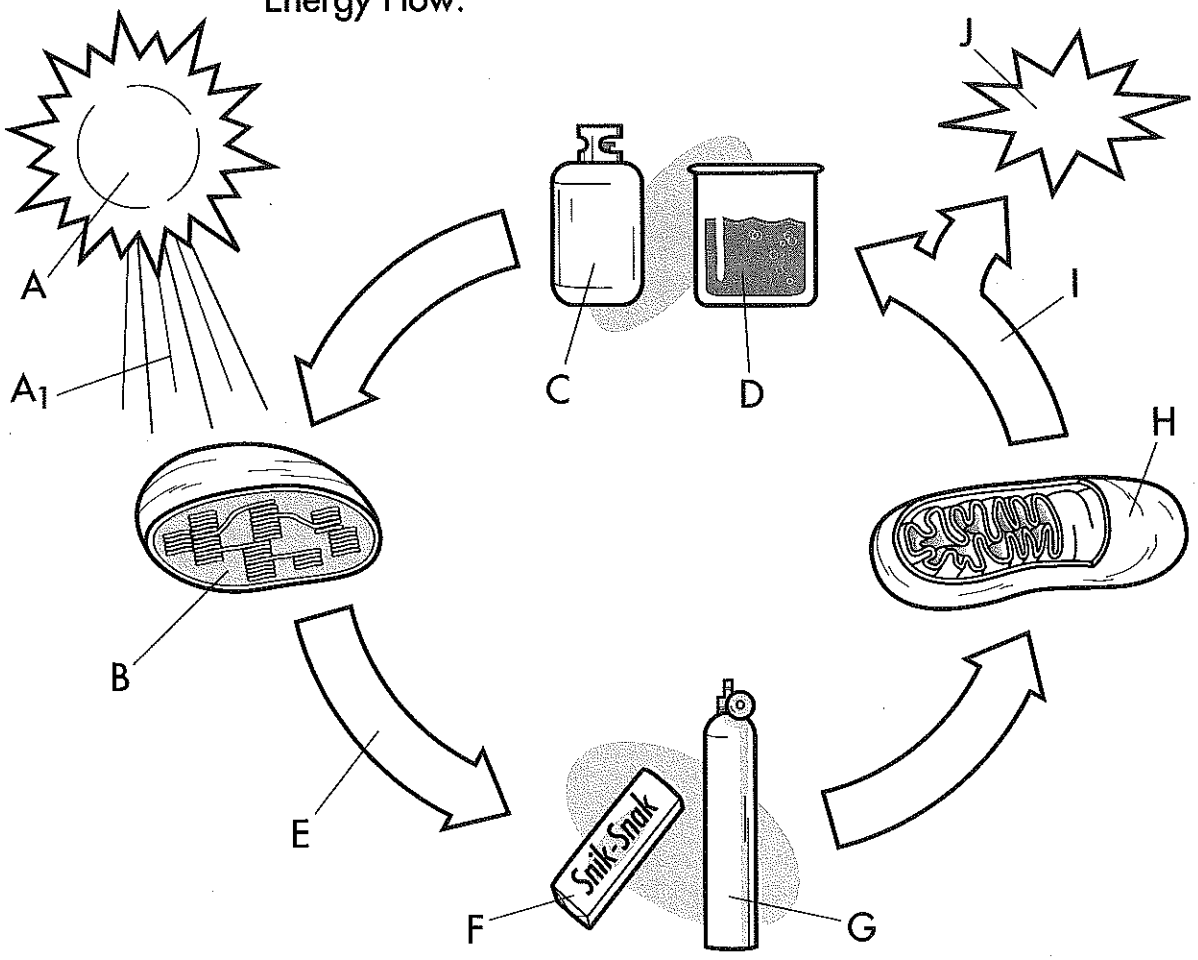
We will conclude with a brief examination of the ATP molecule. Recall that the energy of the ATP molecule comes from the sun. As you read, color the appropriate structures in the diagram.

The adenosine triphosphate (ATP) molecule (J) is shown at the bottom of the plate. You should use a light shade to color the interior of the box, and darker colors should be used for the components of ATP. These components include an **adenine molecule (J_1)** and a **ribose molecule (J_2)**. Adenine is one of the four nitrogenous bases found in DNA and RNA, and ribose is a five-carbon carbohydrate. Attached to the ribose molecule are three **phosphate groups (J_3)**.

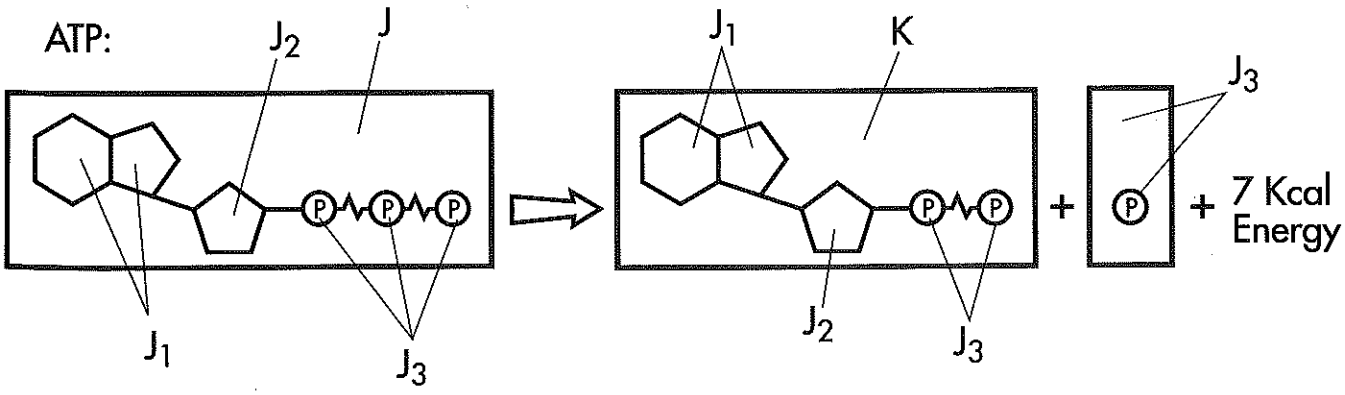
Living things use energy in the form of ATP, breaking it down into **adenosine diphosphate (K)** and an inorganic phosphate group. Adenosine diphosphate (ADP) contains adenine (J_1) and a ribose molecule (J_2), but only two phosphate groups (J_3). During this breakdown, seven kilocalories of energy are given off for use by the cell.

In the following plates, we will study the processes by which ATP is created, such as glycolysis, the Krebs cycle, electron transport, and chemiosmosis.

Energy Flow:

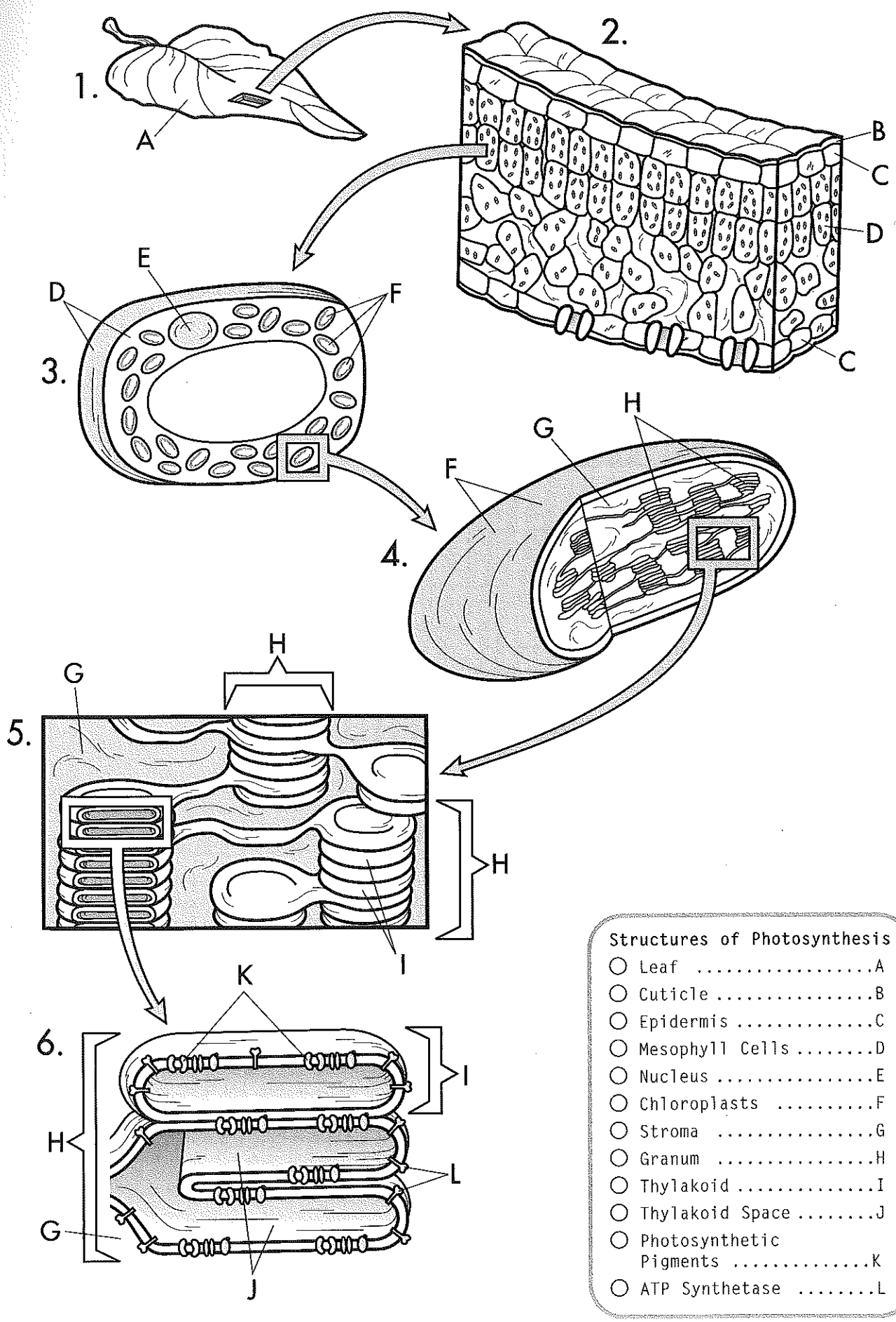


ATP:



Energy Flow in Living Things

- ○ Sun .....A
- ○ Sun's Energy.....A_1
- ○ Chloroplast .....B
- ○ Carbon Dioxide.....C
- ○ Water .....D
- ○ Photosynthesis.....E
- ○ Carbohydrates .....F
- ○ Oxygen.....G
- ○ Mitochondrion .....H
- ○ Respiration I
- ○ Adenosine Triphosphate.....J
  - ○ Adenine .....J_1
  - ○ Ribose .....J_2
  - ○ Phosphate Groups ..J_3
- ○ Adenosine Diphosphate .....K



Structures of Photosynthesis

- ○ Leaf .....A
- ○ Cuticle .....B
- ○ Epidermis C
- ○ Mesophyll Cells .....D
- ○ Nucleus .....E
- ○ Chloroplasts .....F
- ○ Stroma .....G
- ○ Granum .....H
- ○ Thylakoid I
- ○ Thylakoid Space .....J
- ○ Photosynthetic Pigments .....K
- ○ ATP Synthetase L

Chapter 2-9: Structures of Photosynthesis

Photosynthesis is the biochemical process through which plants convert the sun's energy into a usable chemical form. During photosynthesis, a plant produces carbohydrates that provide energy for the plant and are modified in numerous ways to serve as important cellular components.

Photosynthesis is also essential to animals, including humans, who obtain all their food either directly or indirectly from plants. In addition, photosynthesis replenishes the atmospheric oxygen used in animal metabolism.

The reactions of photosynthesis take place within the chloroplasts of plant cells and in the cytoplasm of cyanobacteria. This plate focuses on chloroplasts and describes their structure and function in photosynthesis.

In this plate, we present a series of diagrams starting with the leaf and progressing to the submicroscopic structures involved in photosynthesis.

We will begin with a survey of the main photosynthetic structure of the plant, the **leaf (A)**. Although the leaf is considered the center of photosynthesis, this process also occurs in cells of the plant stem.

In diagram 2, we show a cross section of the leaf. The surface of the leaf is covered by a thin waxy layer called the **cuticle (B)**, under which lie the cells of the **epidermis (C)**. Beneath the epidermis are several layers of cells called **mesophyll cells (D)**. Some of these cells are tall and stacked against each other; these make up the palisade layer of mesophyll cells, while others are more cubical and loosely packed; these comprise the spongy layer of the mesophyll. Mesophyll cells contain the main structures that carry on photosynthesis. At the lower portion of diagram 2 are stomates, where carbon dioxide necessary for photosynthesis enters the leaf.

We have begun our survey of photosynthetic structures by focusing on the leaf and some of its details. We will now take a single cell of the leaf and display its photosynthetic structures. Continue your reading as you color the plate.

Take a look at the single plant cell in diagram 3. This cell is rectangular compared to an animal cell, because plant cells have cell walls that maintain their box-like rigidity.

In diagram 3, we show a single mesophyll cell (D) and some of its major features. For example, the **nucleus (E)** is situated along the edge of the cell because the large central vacuole has pushed it to the side, and within the cytoplasm are a number of **chloroplasts (F)**. These bodies can be seen with a light microscope, but the smaller structures we will mention in this plate can only be seen with an electron microscope. The mesophyll cell contains numerous chloroplasts, which are where the photosynthetic structures are found.

The next view is of a single chloroplast (F) in diagram 4. The fluid-filled space within the chloroplast is known as **stroma (G)**, which is a matrix that holds the functional components of photosynthesis. We now move to diagram 5, in which the chloroplast has been further magnified. You can see stacks of membranous, sac-like vesicles called **thylakoids (I)**. Thylakoids are disc-shaped, and a stack of them composes what is called a **granum (H)**.

We complete the plate with a study of view 6, in which a granum (H) is enclosed by a bracket. The region between the thylakoid membranes is the **thylakoid space (J)**, and this space is also sometimes called the lumen. The space around the thylakoids is the stroma of the chloroplast.

In the thylakoid membranes themselves we see a number of **photosynthetic pigments (K)** embedded in the thylakoid membrane. These pigments, which include chlorophyll, are the biochemical substances involved in photosynthesis. Also embedded in the membrane is a chemical complex called **ATP synthetase (L)**, at which energy from the sun is converted to the energy of ATP molecules. We will explain how this takes place in the next plate.

Photosynthesis Worksheet

Must Knows Covered:

1. What is the overall reaction for photosynthesis?

2. How does this compare to the overall reaction for cellular respiration?

3. Where does the energy for photosynthesis come from?

4. What plant pigments are involved in photosynthesis?

5. Explain why chlorophyll appears green to us in terms of what happens to different wavelengths of light that strike a chlorophyll molecule.

6. How does the amount of energy in light change as the wavelength increases?

7. Which colors of light are most effective for photosynthesis? Explain why.

8. In what organelle of a plant cell does photosynthesis take place?

9. What are the two stages of photosynthesis?

10. In which part of the chloroplast does each stage occur?

11. What happens to water molecules in the light reactions?

12. What photosynthesis waste product is formed in the light reactions?

13. What two products of the light reactions are used up in the Calvin cycle?

_____

14. What happens to carbon dioxide molecules in the Calvin cycle reactions?

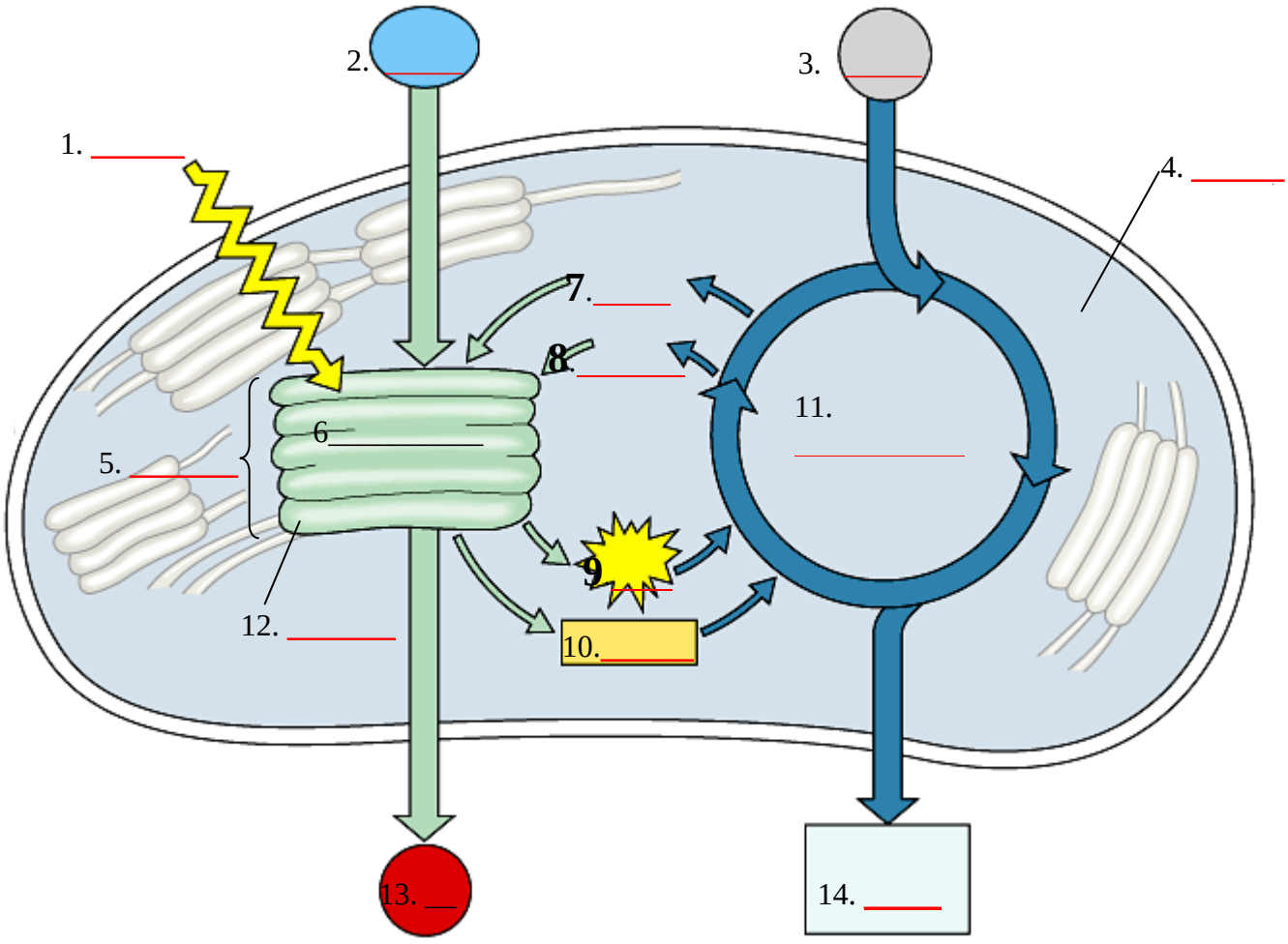
_____

_____

15. How can cells store the sugar that is produced in photosynthesis?

_____

16. Label the diagram below to summarize the two stages of photosynthesis. Use the word bank below the diagram to fill in the blanks.



Word list:

thylakoids	Calvin cycle	CO_2	$NADP^+$
granum	light	NADPH	O_2
stroma	H_2O	ATP	ADP + P
light reactions	sugar		

Chapter 7-11: Transport in Plants

The advantages gained by plants because of their adaptation to life on land are numerous—on land there is more light for photosynthesis, and more oxygen is available for the plant's cellular processes. But in order to live on land, plants had to develop a system for transporting water, minerals, and nutrients throughout their tissues. Minerals and water that are obtained from the soil must be transported upward, and the nutrients that are synthesized through photosynthesis in the leaves must be transported throughout the plant.

As you learned in earlier plates, xylem and phloem are the two components of the plant's vascular system. In this plate, we will discuss how water and nutrients reach the vascular tissues and how they are transported within them.

In this plate, the transport of two substances is discussed: water and nutrients. These are depicted in the two main diagrams in the plate. Begin your work by focusing on the diagram entitled Water Transport as you begin reading below.

In the first diagram, we show the mechanism by which water reaches the xylem tissue in the roots. Two pathways exist. One of them involves the passage of water between porous cells, and the second involves the passage of water from cell to cell. We will begin with extensions of epidermal cells known as **root hairs (A)**.

The **first pathway (B)** is the extracellular route. The water passes through the **epidermis (D)** and courses between the cell walls (intracellular spaces) of the **epidermal tissue (E)** to then enter the **cortex (F)**. Here the water passes around the **parenchyma cells (G)**, which have thin walls and irregular shapes, and are loosely packed.

Next, water comes upon the **endodermis (H)**, which is a single layer of rectangular **endodermal cells (I)** bordered on two sides by a layer of waxy material called the **Casparian strip (J)**. The two cell sides contacting the cortex (F) and **vascular tissue (K)** do not have the Casparian strip, but at this point, water is forced to pass through these adjacent cells of the endodermis. The only way that water can enter the vascular tissue is through endodermal cells.

The water then enters the vascular tissue (K) and passes toward the **xylem (L)**, through which it is transported up the stem of the plant through a cohesion-tension process. The water molecules cling together (cohesion) because of hydrogen bonding and a water column extends up the stem, while the water molecules adhere to the walls of the xylem vessels. At the top of the plant, water evaporates from leaf cells through transpiration, and this loss creates tension that pulls water up through the xylem tissue.

We now focus on the **second pathway (C)**, which is an intracellular route that takes water across plasma membranes and through epidermal cells, cortex cells, and endodermal cells. The cells along this route are all interconnected by channels known as plasmodesmata, and water and minerals pass through these channels to reach the xylem. The water is then pulled upward by the cohesion-tension process.

We now turn our attention to the flow of sugars and nutrients throughout the plant. We will see a process that's very different from the one-way flow of water we saw in xylem tissue. Continue your reading below as you focus your attention on the second portion of the plate, entitled Sugar/Nutrient Transport.

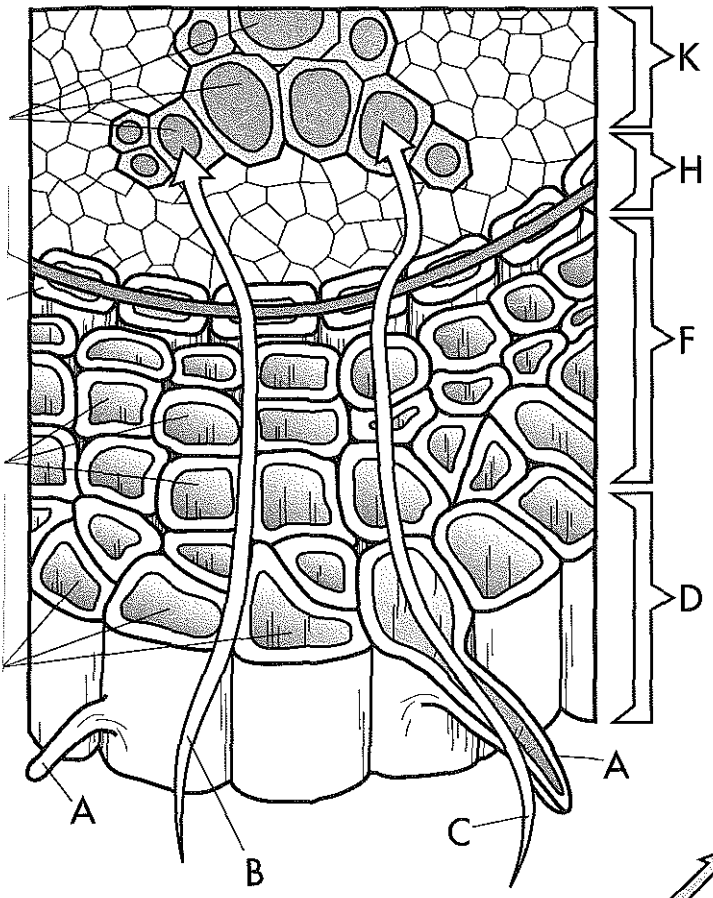
Since photosynthesis takes place primarily in plant leaves, organic materials such as sugars, glucose, and other carbohydrates must be transported from them to other parts of the plant. This transport process is shown in the second diagram. We begin with **water (M)**, represented by the arrow on the right side of the diagram. Water flows up through the xylem (L) through the process we discussed previously.

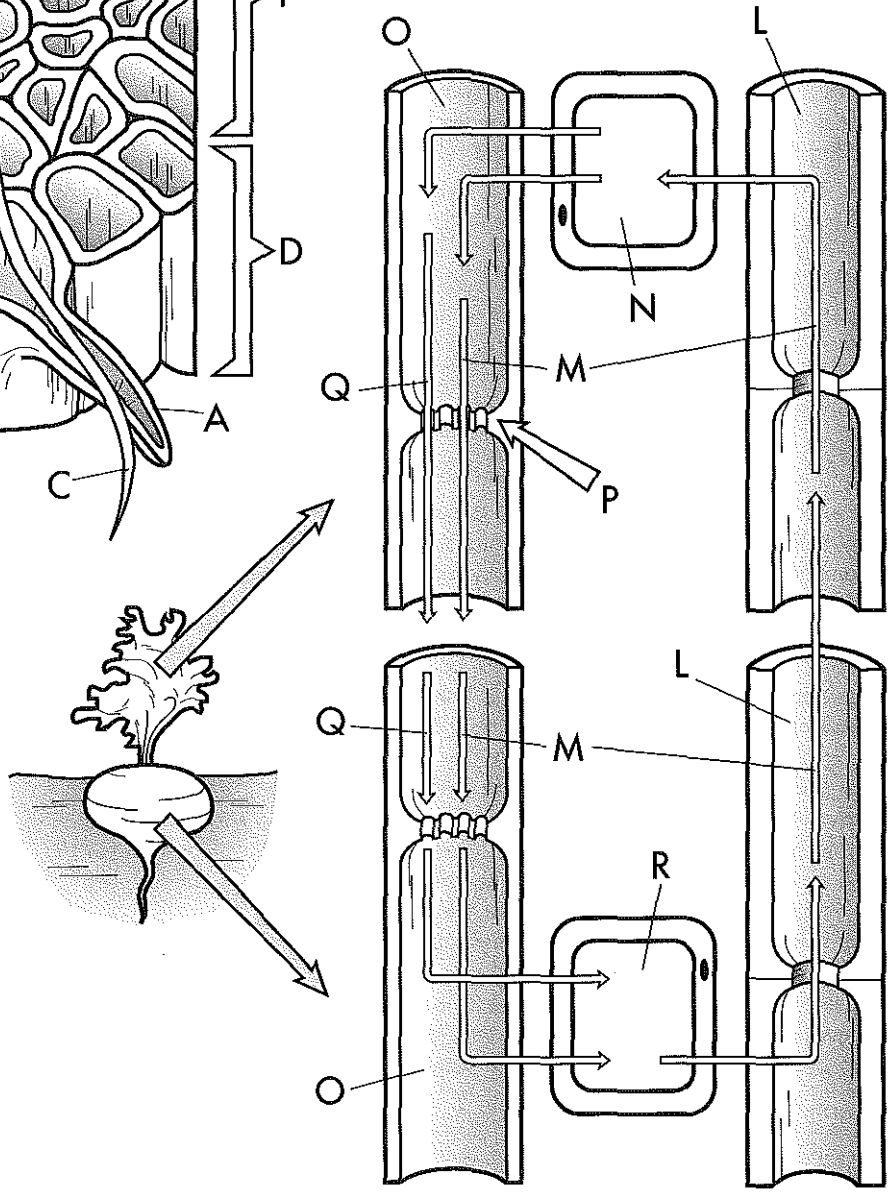
Within the plant leaves, water enters and then exits cells known as **source cells (N)**. Its borders should be colored green, and its interior should be left pale to show that water and nutrients accumulate there. Sugars and nutrients that are produced in the source cells are moved by active transport into the **phloem (O)**.

As the sugar molecules accumulate in the phloem, osmosis forces water into the phloem tubes to dilute the concentrated sugar and nutrient molecules. This additional water entering the phloem forces water through successive **sieve plates (P)** and throughout the plant.

The **sugar/nutrient solution (Q)** will eventually reach a part of the plant in which photosynthesis is not taking place, such as the root. Here the cells are called **sink cells (R)** and in them, nutrients are removed and converted to storage carbohydrates. Water then leaves the sink cells and moves back into the xylem tube, completing the circuit.

Water Transport





Sugar/Nutrient Transport

Transport in Plants

- Root Hair .....A
- First Pathway .....B
- Second Pathway C
- Epidermis.....D
- Epidermal Tissue .....E
- Cortex .....F
- Parenchyma Cells .....G
- Endodermis .....H
- Endodermal Cells I
- Casparian Strip.....J
- Vascular Tissue.....K
- Xylem.....L
- Water.....M
- Source Cell.....N
- Phloem .....O
- Sieve Plates .....P
- Sugar/Nutrient Solution..Q
- Sink Cells .....R

Back Print

Name _____ Class _____ Date _____

Skills Worksheet

Test Prep Pretest

In the space provided, write the letter of the term or phrase that best completes each statement or best answers each question.

_____ **1.** Photosynthetic organisms get energy from
- **a.** inorganic substances.
- **b.** light.
- **c.** autotrophs.
- **d.** heterotrophs.

_____ **2.** Which of the following correctly sequences the flow of energy?
- **a.** bacteria, fungus, rabbit
- **b.** bacteria, sun, flower, deer
- **c.** sun, grass, rabbit, fox
- **d.** sun, hawk, mouse

_____ **3.** ATP molecules
- **a.** produce NADPH.
- **b.** contain five phosphate groups.
- **c.** can both store energy and provide it for metabolic reactions.
- **d.** help a plant produce carbon dioxide.

_____ **4.** In glycolysis,
- **a.** aerobic processes occur.
- **b.** four ATP molecules are produced.
- **c.** four ADP molecules are produced.
- **d.** glucose is produced.

_____ **5.** Which of the following environmental factors does NOT directly influence the rate of photosynthesis?
- **a.** light intensity
- **b.** oxygen concentration
- **c.** carbon dioxide concentration
- **d.** temperature

_____ **6.** Carbon dioxide fixation in the Calvin cycle requires
- **a.** ATP and NADPH.
- **b.** ATP and $NADP^+$.
- **c.** ADP and NADPH.
- **d.** ATP and oxygen.

_____ **7.** When this gas is available, aerobic respiration follows glycolysis.
- **a.** carbon dioxide
- **b.** oxygen
- **c.** hydrogen
- **d.** water vapor

Question 8 refers to the chemical equation below.

$$3CO_2 + 3H_2O \xrightarrow{\text{light}} C_3H_6O_3 + 3O_2$$

_____ **8.** This equation summarizes the overall process of
- **a.** cellular respiration.
- **b.** photosynthesis.
- **c.** the Calvin cycle.
- **d.** the Krebs cycle.

Name _____ Class _____ Date _____

Test Prep Pretest *continued*

_____ **9.** Which of the following is NOT part of cellular respiration?
- **a.** electron transport chain
- **b.** glycolysis
- **c.** Krebs cycle
- **d.** Calvin cycle

_____ **10.** Electrons in pigment molecules become excited
- **a.** when light strikes a thylakoid.
- **b.** when water molecules are broken down.
- **c.** during light-independent reactions.
- **d.** during the Calvin cycle.

Complete each statement by writing the correct term or phrase in the space provided.

11. The carrier protein that transports hydrogen ions across thylakoid membranes and produce ATP acts as both a(n) _____ _____ and a(n) _____ .

12. The _____ _____ is the most common method of carbon dioxide fixation.

13. Aerobic respiration occurs in the _____ of eukaryotic cells.

14. Plants use sugars produced during _____ to make organic compounds.

15. During photosynthesis, light energy is converted to _____ energy.

16. During anaerobic processes, NADH transfers electrons to the pyruvate produced during _____ .

17. Glycolysis is a biochemical pathway that breaks down a six-carbon glucose molecule to two three-carbon _____ .

18. During aerobic respiration, pyruvate is first converted to acetyl-CoA, which enters the _____ _____ .

19. During cellular respiration, a cell produces most of its energy through _____ respiration.

Name _____ Class _____ Date _____

Test Prep Pretest *continued*

20. Light-absorbing _____ are located in the membranes of _____ .

Read each question, and write your answer in the space provided.

21. Explain how the metabolism of heterotrophs differs from that of autotrophs.

22. Explain how ATP provides energy for cells.

23. Briefly explain how ATP is produced by electron transport chains during photosynthesis.

Name _____ Class _____ Date _____

Test Prep Pretest *continued*

24. Describe how environmental factors affect the rate of photosynthesis.

25. ~~Explain the benefits and uses of lactic acid fermentation and alcoholic fermentation.~~